

Membrane Structure

5. About sixty years ago, Gorter and Grendel estimated that erythrocytes contain sufficient lipid to form a bimolecular lipid plasma membrane. With the benefits of more modern techniques we now know these pioneers made two errors in their measurements:

- Their lipid extraction procedures (with acetone) removes only about 75% of RBC lipid. More stringent extraction—using chloroform and methanol—removes 100% of the lipid.
- Their estimates of RBC surface area were made on stained blood smears (a thin, stained film of dried blood) and yielded an average value of $99.4 \mu^2$ per cell. More recent measurements using Nomarski differential interference microscopy and living cells suspended in serum indicate a surface area of $138 \pm 17.3 \mu^2$.

A. (8 pts) How did Gorter and Grendel reach their conclusions. What sorts of measurements did they perform and how did the results lead to their conclusion?

B. (5 pts) Assuming the recent determinations are more valid, how might the original inference of Gorter and Grendel be critically re-evaluated? Be specific.

C. (8 pts) Do the new data provide any additional information concerning our modern view of plasma membrane organization? Support your answer with a brief discussion.

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5.A. Here's a slightly more complex and interesting version of Problem 1:

(The membrane of a canine red blood cell has a surface area of about $195 \mu^2$, is about 75 \AA thick and contains 0.7 picograms ($1 \text{ pg} = 10^{-12}\text{g}$) of lipid and 0.8 pg of protein. The lipid consists of approximately equal numbers of phospholipid and cholesterol, which have molecular weights of about 800 and 380 respectively. In a tightly compacted, model monolayer in a Langmuir trough, each phospholipid occupies a surface area of 0.55 nm^2 and each cholesterol, 0.38 nm^2 . **In answering the questions below, show all calculations.**

A. (5 pts) If one assumes an average molecular weight of 60,000 for RBC membrane protein, how many protein molecules are there associated with a single canine RBC membrane?

B. (8 pts) What is the ratio of lipid to protein, on a weight basis? On a molecular basis?

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C. (5 pts) What proportion of the total canine RBC surface area is occupied by lipids?

D. (8 pts) What assumption(s) did you make in calculating your answer to C. above? How does your model of membrane organization change if the assumption(s) change?